DESIGN OF AN INFRA-RED OPTOCOUPLER BASED MOBILITY AID FOR THE BLINDS

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Dated: 12^{th} May, 2014

CERTIFICATE

This is to certify that the thesis titled, "**Designing of an infra-red optocoupler based mobility aid for blinds**" submitted by Dablu Ranjan Kumar (Roll no. 110BM0451) in partial fulfilments for the requirements for the award Bachelor of Technology Degree in Biomedical Engineering during Session 2010-2014 at National Institute of Technology, Rourkela and is an authentic work carried out by them under my supervision and guidance.

(Dr. KUNAL PAL)

Assistant Professor

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Date: Dablu Ranjan Kumar

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ABSTRACT

In the last decade, there has been an exponential increase in the research being carried out on wearable devices. The research on wearable devices still in its nascent stages and hence there are not many commercial devices available for improving the lifestyle of the differently-abled persons. Hence in this study, we have made an attempt to device a wearable electronic travelling aid for the blinds using IR based distance monitoring sensors. The device has been designed to generate audio signals to alarm the user about the presence of an obstacle. The user can manipulate the device to have information about the aerial obstacles. 10 volunteers were trained on the device who reported that the device was user-friendly. They also share this device is easy to operate and their hand are also free to do some another work. And another benefit is that IR sensor is sharp detector it can easily detect path between two obstacles.

Keywords: IR-optocoupler, mobility aid, distance sensor

CHAPTER-1 INTRODUCTION

1. INTRODUCTION

Recent analysis of data by various sources has shown that the current population deprived of eye sight in the world goes up to ~45 million [1]. In addition to this lot of completely visually hampered population ~135 million people are there who have very low eye sight or are suffering some or other kind of disease[2]. Study have also put forward that approximately ~87% of this population is contributed by underdeveloped/developing countries[3]. Another study have revealed that the all the persons dying in a healthy condition if voluntarily donate their ayes to the blinds, the number of blinds would reach zero within a year[4].

But there has been a continuous advancement in the medical sciences which has resulted in a decreased death rate. This scenario has been studied and the conclusion made was that the number of blinds at present might increase two fold by the end of year 2020[5].

A blind person is deprived of a proper communication and interaction with their surrounding and thus fail in many of the daily activities when try on their own. Visually impaired beings were thus given assistance in the form of another sighted guide or guide dogs[6]. This method required to hire a willing person to take care of the deprived one or to get a trained guide dog as pet. Both of the methods helped in restoring the mobility of the person. Now, since the majority of the blind population hail from underdeveloped/developing countries, they can’t afford the maintenance cost for a sighted being or a guide dog. The methods are neither cost effective nor efficient so that scientists have been doing research on various electronic travel aids[7]. The blind persons are deprived of their visual senses, so, the navigation aids need to provide them a feedback either via auditory senses or tactile means[8]. A number of electronic travel aids present are hand held cane with a number of sensory objects which detect the obstacles present in the surroundings and feed the user with an alarming feedback. This type of navigation aids are not that very handy and are difficult to use in home-office environments.

Here proposed is a wearable device which is capable of detecting aerial obstacles, suitable for house-hold-office environments and can also be used easily in crowded areas where the scope of use of cane based navigation aids is limited. Since devices as such are at the first stage, a lot of scope is there in their development and improvements.

The device uses the distance measuring features of IR sensors. IR sensor is very low cost and can measure the distances with very good efficiency[9]. The module contained a pair of transmitter and receiver coupled with necessary optical filtering mechanism and amplifying circuits. Arduino UNO was used to acquire the signals and hence to detect the obstacles[10]. The device has two thresholds set as > 45 and < 90 cm. The device is capable of detecting obstacles with continuous scanning whether aerial or ground.

2. LITERATURE AND REVIEW

Research work is being performed in various institutes in the world to provide a safe walking device for the blind. Important parameters to keep in consideration are cost effectiveness and ease of operation. Initial aim was to provide safety from obstacle present in his way. Without any help previously blind people used to commute from one place to another only when accompanied by a normal person[10]. Some blind person also use a long stick in their hand and at the time of walking they move the stick in front of his way from left to right and right to left. If obstacle came in his way then they find by his stick and safely cross from there. After that devices have been designed to detect obstacles more effectively. A white cane are used by many people who are blind. By using this cane they can feel, where obstacle is and where is path. It is a modern form of long stick. Their main property are long, light weight and foldable. So their portability are easy. White cane is world's most used cane for navigation of blind people[11]. Apart from these several other electronic devices are use in navigation for blinds. Blind Navigator detects an obstacle and guides the person away from there with the use of audio instructions[12]. The concept behind it is that the system must take action whenever it encounters an obstacle. The embedded system is dedicated to specific tasks. The blind navigator uses two types of sensors

1. Ultrasonic sensor

2. Infrared sensor.

An Arduino is used to control electronic devices. An Arduino Contains all the memory and interfaces needed for a simple application. The mechanism of audio instruction is achieved with the help of an APR[12]. The importance of our system is that the system is used for both indoor and outdoor use and also can be used with stick or without stick. In this respect, a simple, inexpensive, user friendly, quick responsive blind guidance systems are designed and implemented in order to improve the mobility and efficiency of movement of both visually impaired people and the blind[13]. The work proposed includes an equipment that is wearable and consists of a head hat and/or a mini hand stick to help the visually impaired people navigate by themselves safely and avoid any obstacles whether fixed or mobile, thereby prevent accidents. The major component of this system is an infrared sensor which scans a predetermined area around the blind person by emission of reflecting waves which are infrareds in nature. The reflected signals which are received from the barrier object are used as inputs signals to the PIC microcontroller[14]. The Arduino is then used to determine the distance and the direction of the objects around the blind[15]. The microcontroller also controls the peripheral components which can alert the blind person about the shape, material and direction of the obstacle encountered. The advantages of this system is that it is fast, cheap, easy to use and is an affordable solution for the visually impaired people and the blind..

CHAPTER – 2 HARDWARE DESIGN AND DESCRIPTION

This chapter describes the hardware that is being used in the project.

A. Hardware Requirements

1. IR Proximity sensor (**GP2Y0A710K0F**)

2. Arduino UNO

3. LED (Three different colors)

4. Power source (9 volt rechargeable battery)

5. Buzzer

- **IR Proximity sensor (GP2Y0A710K0F)**

IR Proximity sensor (model no **GP2Y0A710K0F)** is obstacle detector sensor[16]. It can detect obstacles in a very appreciable distance of about 100 to 550 cm. It consists of three separate unit including positive sensitive detector (PSD), infrared emitting Diode (IRED) and signal processing circuit. Every component performs significant function. IRED emits infrared rays which are used to sense any obstacle. After interacting with an obstacle the rays rebounds and are received by PSD. The signal processing unit change the received signal in an appropriate and readable form. IR proximity sensor is designed as a sharp detector sensor. Their sensitivity does not affect by physical parameters like environment temperature, pressure, humidity and operating duration.

Features

1. Long distance type

   Distance measuring range: 100 to 550 cm

2. Analog output type

3. Package size: 58×17.6×22.5 mm

4. Consumption current: Typ. 30 mA

5. Supply voltage: 4.5 to 5.5 V

Application:-

1. Projector (for auto focus)

2. Robot cleaner[17]

3. Auto-switch for illumination, etc.[18].

4. Human body detector

5. Amusement equipment (Robot, Arcade game machine)

The block diagram

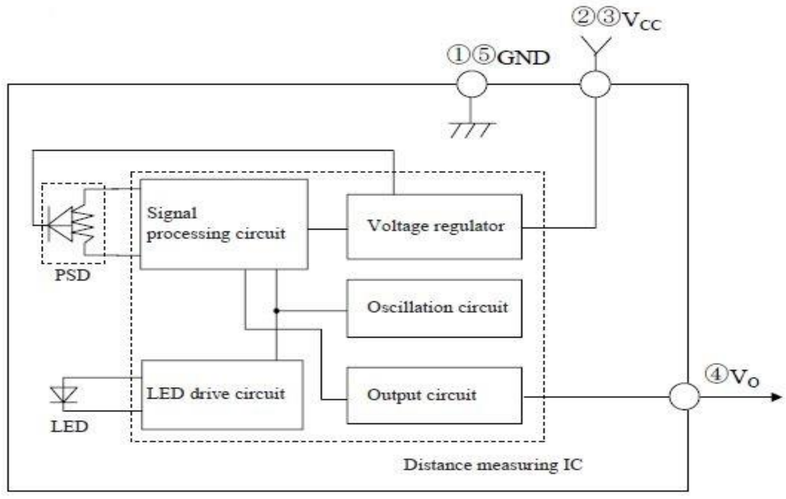

Figure 1 Block diagram of IR sensor

Timing chart of IR Proximity sensor

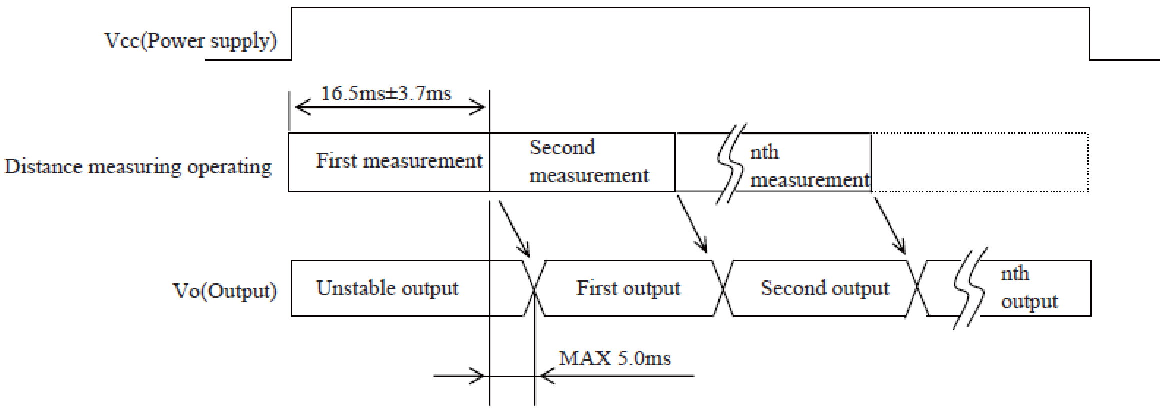

Figure 2 Timing chart of IR Proximity sensor

Picture of IR Proximity sensor

Figure 3 Picture of IR proximity sensor

When I take the observation of distance vs. output voltage characteristic then I observe when increase the distance from 0 to 20 cm then output voltage increases exponentially and after that decreases and after 500cm their output voltage get saturated. Their output voltage range I have consider are 0.5V to 2.6V.

The characteristic graph

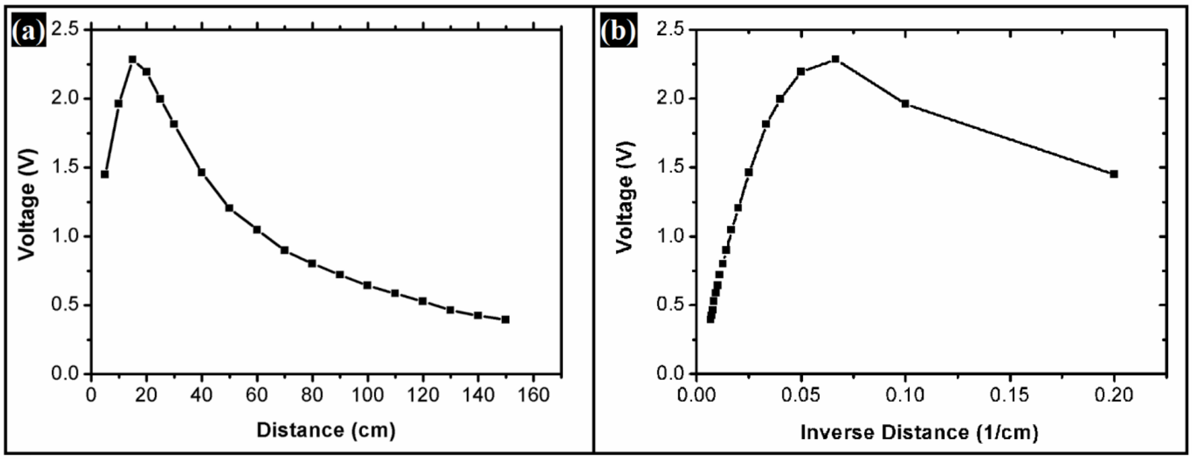

Figure 4 Characteristic Graph of IR proximity sensor

- **Arduino UNO**

Arduino Uno is a single board microcontroller board based on ATmega328.

It has 14 digital input/output pins in which 6 pins can be used as a PWM outputs. It has also 6 analog inputs, a USB connection, a 16 MHz ceramic resonator, a power jack, an ICSP header and a reset button. It contain everything needed to support the microcontroller in a single board. Arduino Uno can sense the environment by using sensor, sensor receive the signal from environment and send to the input part of Arduino, Arduino give the output from the output part as the programming burn in the microcontroller. Arduino accept a programming software called sketch. An Arduino can program infinite time. If a new program burn in the Arduino then previous program will automatically vanish. We can use multiple of sensor at a time and all the instruction should be in one program.

16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

Features

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz

The Arduino Uno with Atmega 328 has 32 kb memory in which 0.5 kb used in boatload. It also has 2 KB of SRAM and 1 KB of EEPROM

Application of Arduino

To develop any sensor based prototype equipment.

Develop any LED blinking circuit.

Xoscillo: open-source oscilloscope

- Arduino Phone
- Scientific equipment

Picture of Arduino

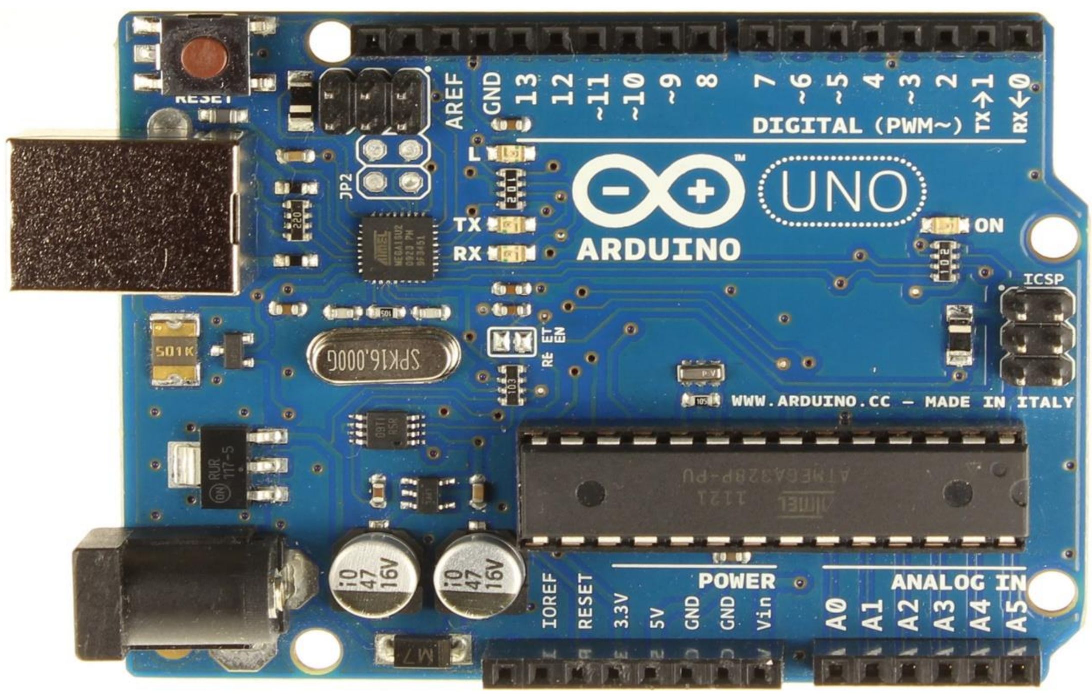

Figure 5 Front view of Arduino UNO

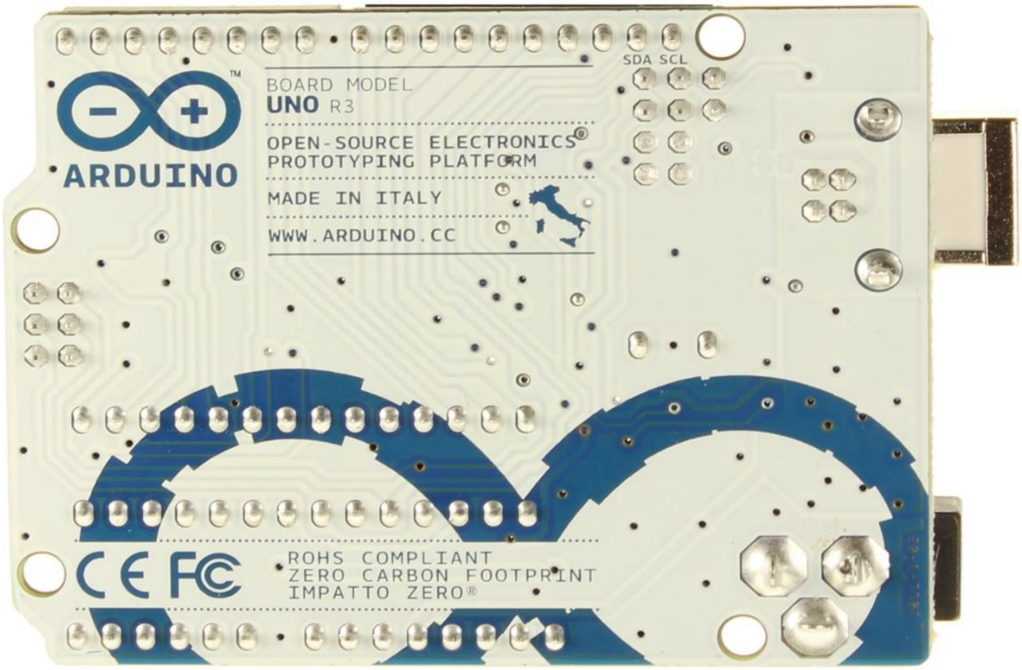

Figure 6 Rear View of Arduino UNO

- **LED**

LED is a light emitting Diode which is made of semiconductor. It has two pin semiconductor. It emit the light. There are various color of led. Here I have used three color of led yellow, red and green.

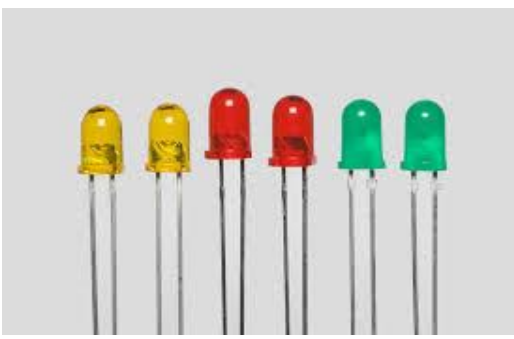

Figure 7 Picture of LED

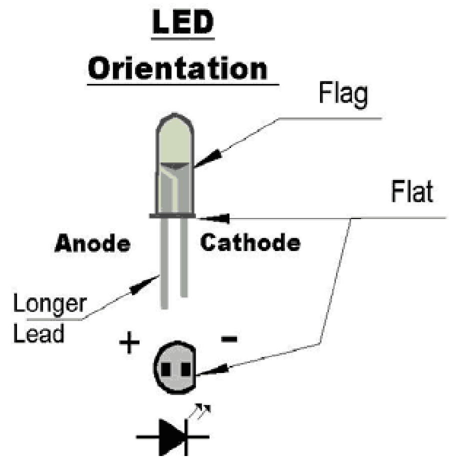

Figure 8 Schematic Diagram of LED

- **Power source**

Here I have used 9 V DC power source by using Rechargeable battery.

Since Arduino need 9 V input power maximum so the most common 9 volt dc power source is transistor battery. I can operate my prototype by using this battery is around 30 minutes. It is small in size weightless and easy to carry with this prototype.

Units per box/card: 1

Voltage: 9V

Capacity: 175mAh

Dimensions: Height: 49mm, Width: 18mm, Depth: 27mm

Item Codes: 9V, 6LR61, MN1604, PC1604, 1604LC, K94, 6AM-6, 4022, E-BLOCK, 6AM6

Chemistry: NiMH

Weight: 52g

EAN Code: 7638900138771

SKU: 2126

Figure 9 Specification of Power Source

Figure 10 Picture of battery

- **Buzzer**

Buzzer or beeper is is an audio signaling device. Typically use the buzzer or beepers are in alarm device and as an indicator.

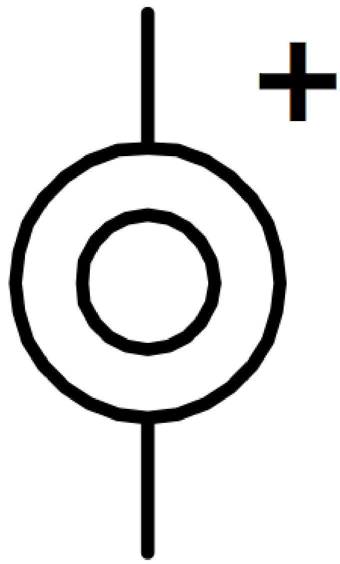

Figure 11Electronic symbol of buzzer

Figure 12 Picture of buzzer

CHAPTER – 3 SOFTWARE DESIGN AND DESCRIPTION

This chapter describes the software that is being used in the project.

Software Requirements

Software which is used in Arduino are called sketch. These sketch are written in the text editor. Arduino program saved with the file extension .ino. It has the option of cut pest. At the time of compiling error part become highlighted and if there is no any error then then indicate there is no any error.

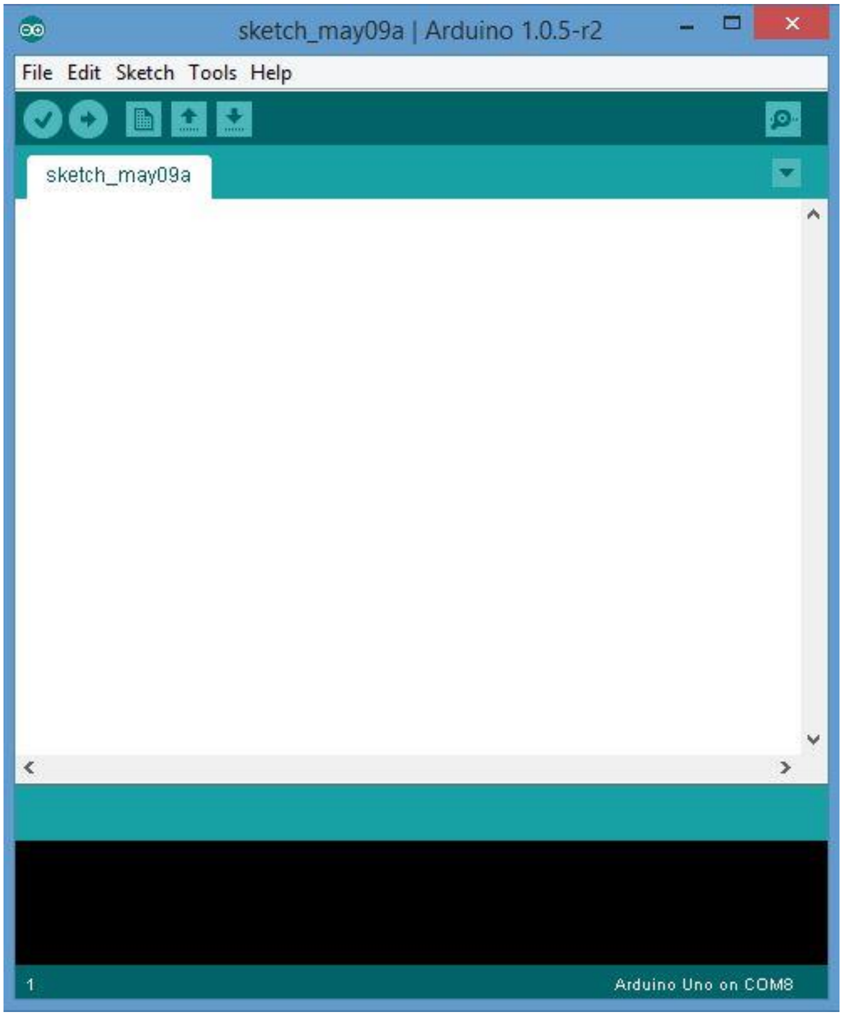

Figure 13 sketch software interface

Program was written, compiled and then uploaded in Arduino using sketch. The algorithm flowchart are given below (figure 14)

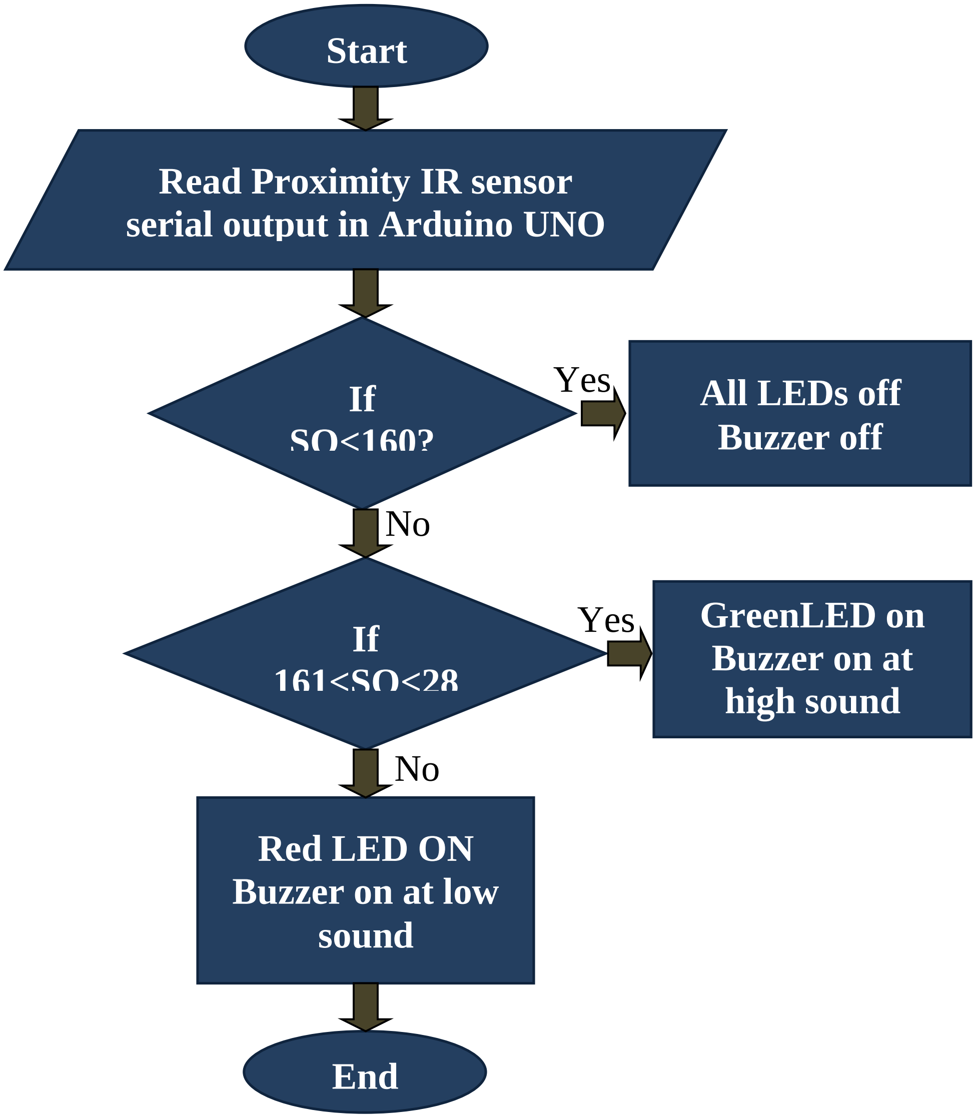

Figure 14: Flow chart of the decision making process

CHAPTER – 4 IMPLEMENTATION

1. IMPLEMENTATION

The IR Proximity sensor (**GP2Y0A710K0F**) are connected with analog input pin of Arduino. Arduino receive the signal of sensor and give the output by Digital PWM pin. An external power source are connected with the Arduino for operating the prototype.their rating are 9 V DC transistor battery. A buzzer or beeper is connected with output pin of Arduino and another two output for indicating the threshold value are connected with two different color of LED. The buzzer beeping voice are two different frequency at different range of threshold value. When obstacle is in range in from 10 to 45 cm then buzzer beeping at highest voice and when the obstacle is in range from 44 to 90 cm then the buzzer voice become half. A user can differentiate the distance of obstacle form the user. If the buzzer voice is high then it means the obstacle is very close from him and if the buzzer voice is low, it means obstacle is little away from user and if buzzer is not beeping then it means there is no any obstacle. The block diagram of the prototype is given below

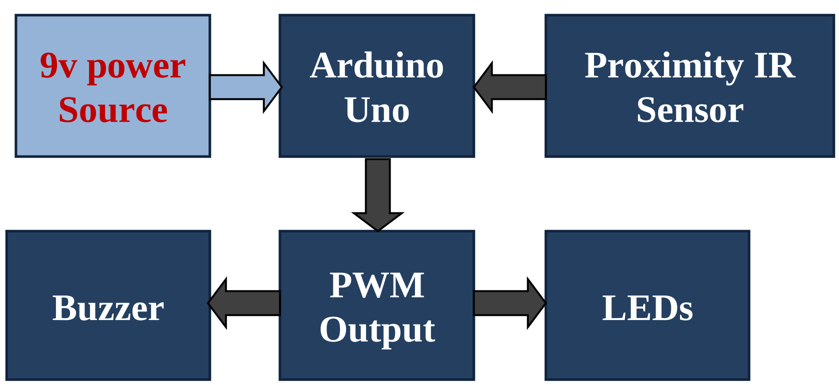

Figure 15 Block diagram of prototype

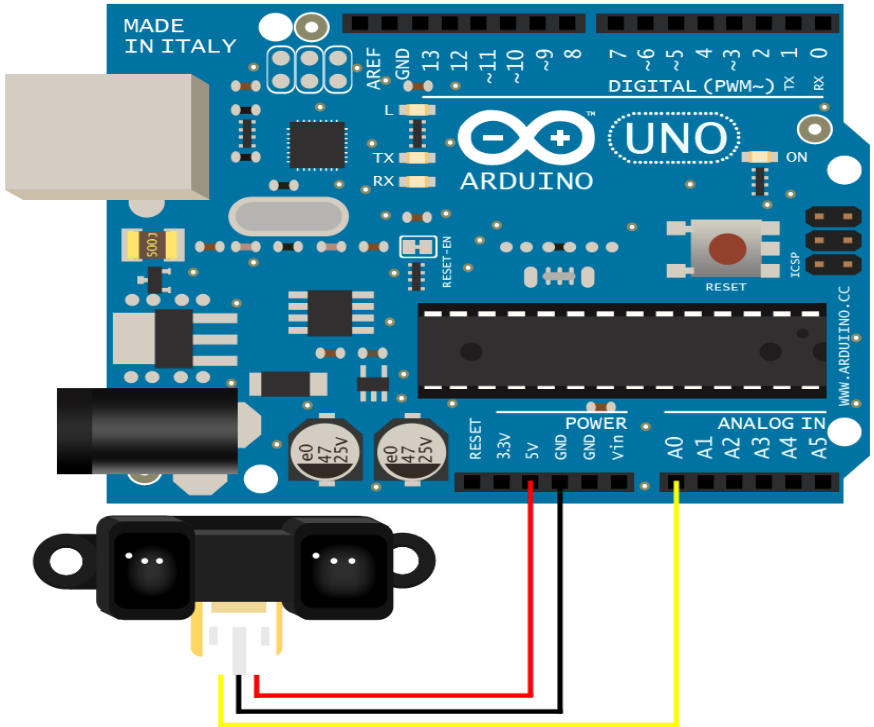

Figure 16: Connection of IR Proximity sensor with Arduino

The Arduino was powered using a 9V battery. The programming in sketch was made for the microcontroller to detect the distance ranges from 10 to 90 cm. The presence of any objects within this range resulted in the generation of the control signals. The efficiency of the system was tested by controlling the glowing of a 2 LED panel. Yellow LED was glow when the distance was ≤ 90 cm and Red LED was glow when the distance was ≤45 cm

In each of the hand gloves, a separate IR sensor and one Arduino were attached. Both the IR sensors were working independently. The sensors were made to detect obstacle distances when the objects were closer than 90 cm and 45 cm, respectively.

CHAPTER-5 RESULT AND DISCUSSION

RESULT AND DISCUSSION

Here the device studied and developed was based on IR optocoupler. The device was a step ahead in the area of wearable electronic travel aids. The device uses 2 IR proximity sensor for distance measurement and hence the obstacle detection. The IR proximity module is a set of an IR LED to transmit light and an IR photodiode to receive the reflected obstacle rich signal. The design of the sensor is such that signals carrying information of the obstacle are with least distortion due to factors like glare reflection or color. The transmitting end, IR LED, irradiates signals of 40 Hz frequency. These signals are reflected back and are received by the receiving module, the photodiode. The sensor works in the principle of the detection of the transmitted IR light reflected from the objects/obstacles. The received signals at the photodiode leads to change in its conductivity which results in voltage variation as per the characteristic graph obtained. The characteristic graph explains that in absence of any obstacle the voltage change is not observed and hence it remains at low state. The whole set up was calibrated using obstacles at measured distance and the distance measured by the sensor displayed on serial monitor. Below shown is the set up for the calibration (Figure 18).

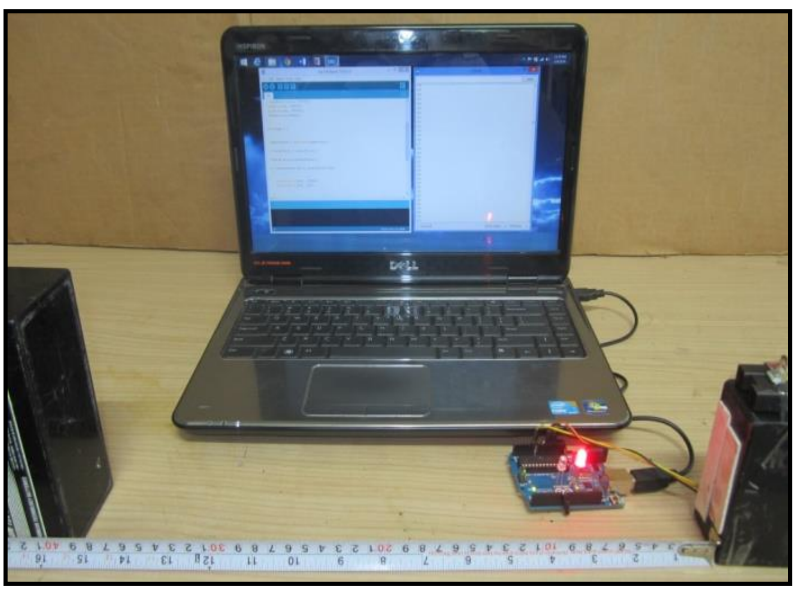

Figure 17: Setup of calibration of sensor

Figure 18: The Final prototype of the proposed device.

Final prototype of the proposed device is shown in figure 18. The device is a pair of gloves mounted with the IR proximity sensor. The characteristic graph shows an initial increase in the voltage with a corresponding increase in the distance and then after an exponential decrease is observed as the distance was further increased (figure 19).

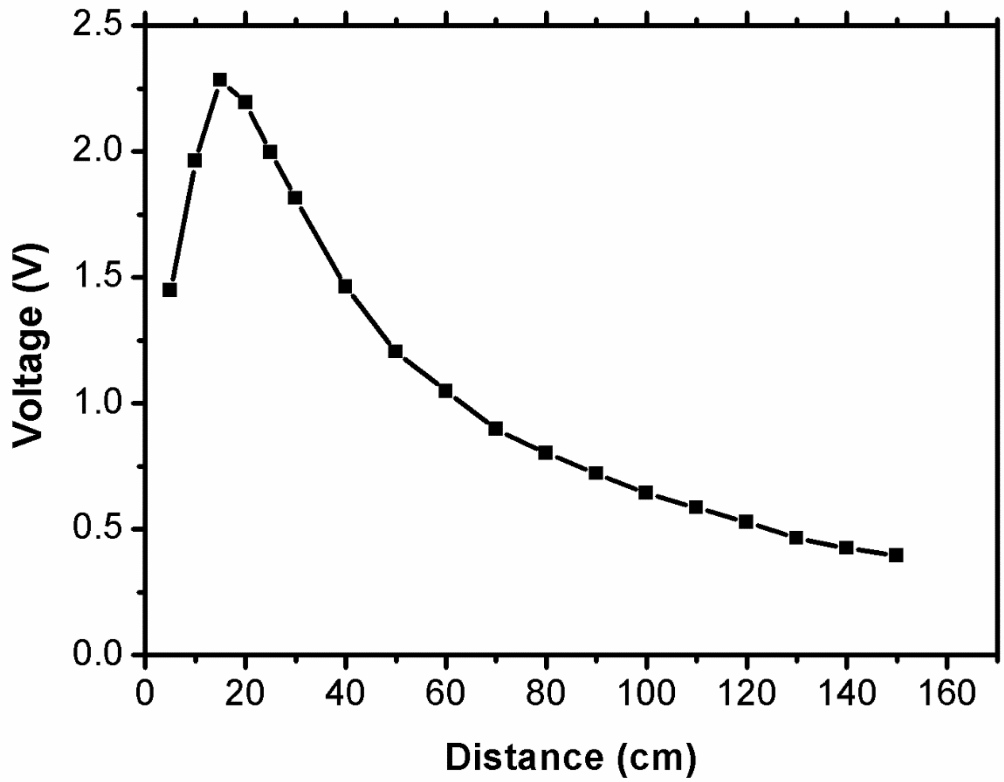

Figure 19: voltage vs. distance graph of IR Proximity sensor (GP2Y0A710K0F)

The variation in the nature of the graph is shown in the same figure and linearity was observed by plotting the graph of the voltage vs. inverse of the distance (Figure 20).

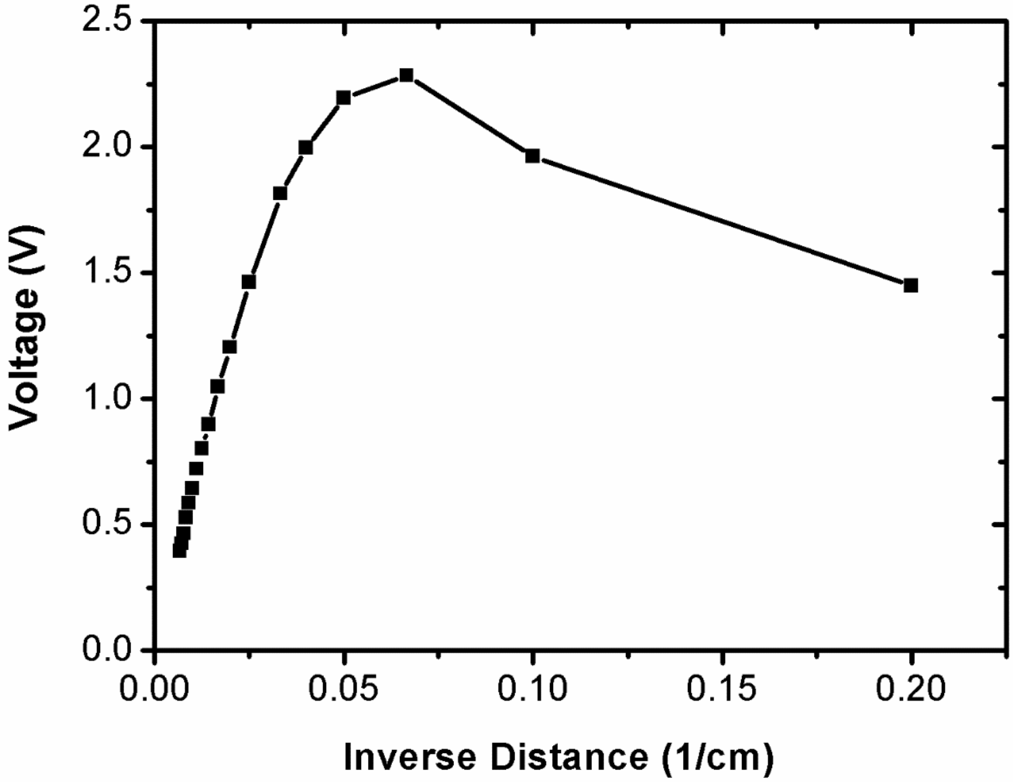

Figure 20: voltage vs. distance graph of IR Proximity sensor (GP2Y0A710K0F)

The calibration curve obtained by plotting the graph was obtained similar to that presented in the datasheet by the manufacturer.

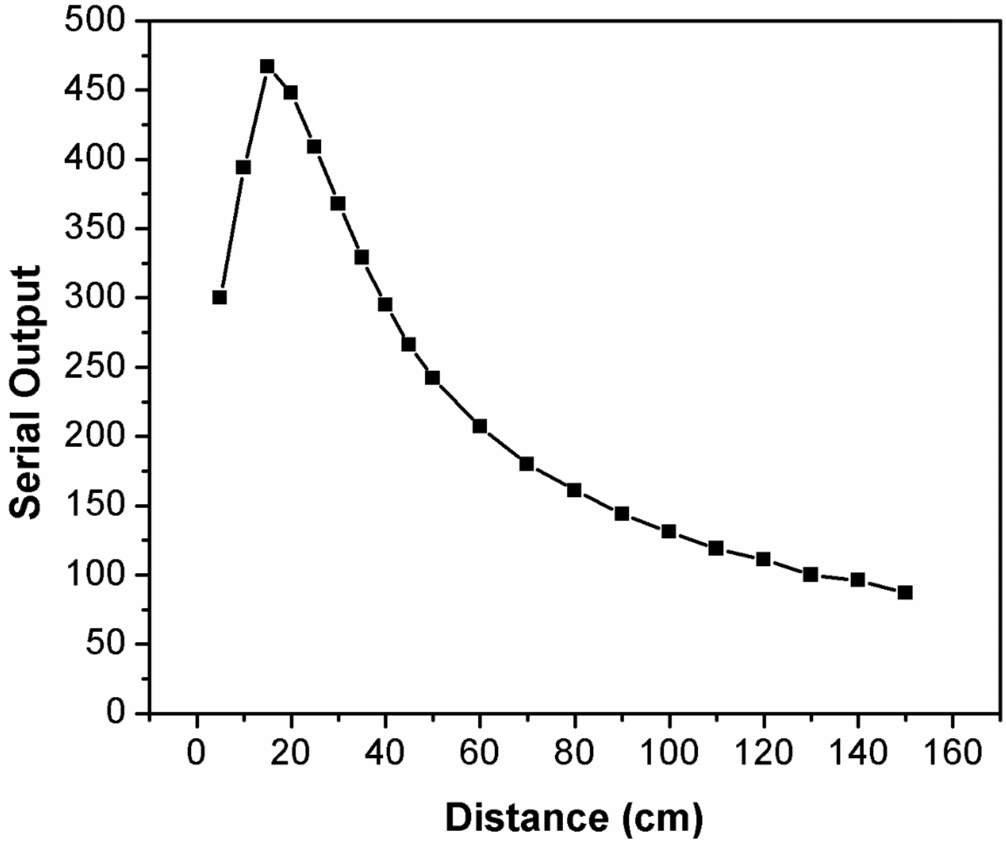

Figure 21: Serial monitor output vs. distance graph of IR Proximity sensor (GP2Y0A710K0F)

Again the same plot was again plotted by taking the readings from serial monitor (figure 21) and again it was obtained the same, even the plot of serial monitor output vs. distance inverse was same (figure 22).

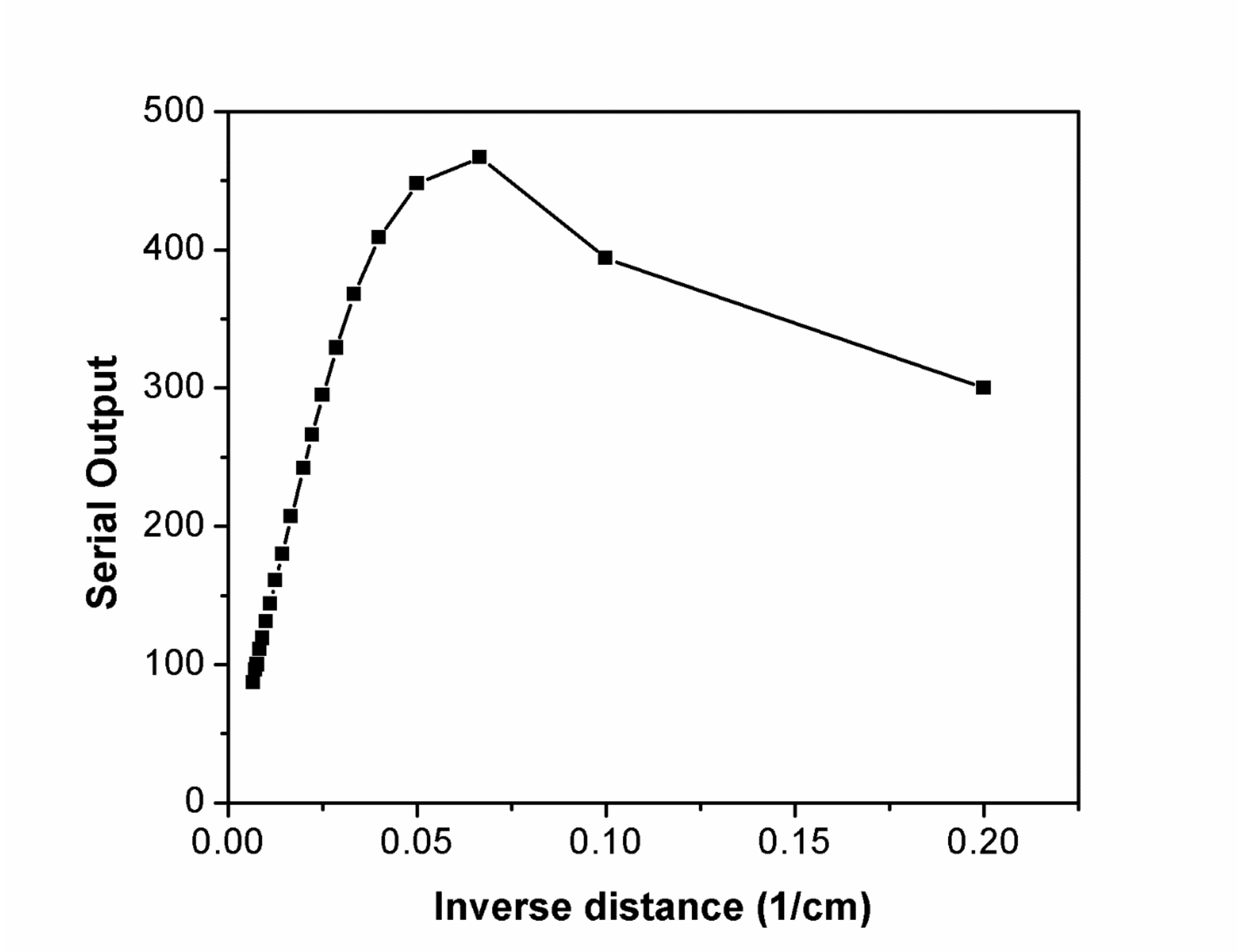

Figure 22: Serial monitor output vs. Inverse distance graph of IR Proximity sensor (GP2Y0A710K0F)

CHAPTER – 6 CONCLUSION AND FUTURE SCOPE

1. CONCLUSION

Various applications of IR proximity sensor have been tried for controlling and guiding the mobility of robots. The implementation of these sensors have seen a continuous improvement with the advancing technologies. Also, the low cost of these sensors have given an edge to them over the ultrasonic sensor. Though under various implementation condition the effective range of the devices can be varied accordingly. The developed device is attached to a pair of gloves which are wearable and thus keeps the hand free for other purposes. Unlike the other stick based electronic travel aids this device can be easily used in crowded places. Similarly the device can be a good choice for household or office environment.

2. FUTURE SCOPE

In future we can replace the buzzer by vibrator then the user can easily feel the feedback of the sensor. The advantage of vibrational feedback is that the external noises will be automatically cut-off. Another modification that be can be made in this device is by addition of PIR sensor so that living obstacle can be differentiated from non-living.

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